




ORIGINAL ARTICLE

Changes in dental and medical visits before and during the COVID-19 pandemic among U.S. children aged 1–17 years

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Abstract

Objectives: The COVID-19 pandemic has tremendously impacted the U.S. healthcare system, but no study has examined the impact of the pandemic on utilization of dental care among U.S. children. Changes in past-year dental versus medical visits and perceived unmet health needs between 2019 and 2020 among U.S. children aged 1–17 years were examined.

Methods: National and state representative, cross-sectional data from the National Survey of Children's Health conducted during June 2019–January 2020 (i.e. pre-pandemic, $n = 28\,500$) and July 2020–January 2021 (i.e. intra-pandemic, $n = 41\,380$) were analysed. Any past-year visit and perceived unmet needs (i.e. delay or inability to receive needed care) were reported by the parent proxy. Weighted prevalence estimates were compared using two-tailed chi-squared tests at $p < .05$. Poisson regression analyses were used to explore the relationship between having dental and/or medical unmet needs during the pandemic and indicators of poor health and social wellbeing.

Results: Between 2019 and 2020, a significantly reduced prevalence of past-year medical (87.2%–81.3%) and dental visits (82.6%–78.2%) among U.S. children aged 1–17 years (all $p < .05$) were observed. Correspondingly, perceived unmet needs increased by half for dental care (from 2.9% in 2019 to 4.4% in 2020) and almost one-third for medical care (from 3.2% to 4.2% in 2020). Subgroups with the highest prevalence of unmet dental need included those with low socio-economic status, living with their grandparents, uninsured and living with a smoker.

Conclusions: Unmet health needs increased in general but increased more for dental than for medical care among U.S. children aged 1–17 years. Enhanced and sustained efforts will be needed to deliver targeted services towards disadvantaged segments of the population to narrow existing disparities.

KEYWORDS

children, COVID-19, dental care, dental office, needs assessment, office visits, primary health care

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1 | INTRODUCTION

The ongoing COVID-19 pandemic has had a tremendous impact on the healthcare systems of affected countries. With regard to the impact on the utilization of healthcare services, a systematic review found that the overall healthcare utilization across 20 countries had declined by one-third during the pandemic.¹ Within the United States (U.S.), as of 30 June, 2020, because of the pandemic, 40.9% of adults reported delaying or avoiding their medical care, of which, 11.7% and 31.5% were attributed to urgent or emergency care and routine care, respectively.² Utilization of dental care was similarly impacted; a U.S. study found a 33% reduction in weekly visits to dental clinics from January to August 2020, compared with the same time frame in 2019.³ Studies outside the U.S. showed a reduction in utilization of paediatric dental care as well.⁴⁻⁷

Even before the pandemic, dental care in the U.S. was already utilized to a lesser extent than primary medical care, especially among disadvantaged communities.⁸ It is presumed that the pandemic had a greater impact on the utilization of dental services than medical care. This is because early in the pandemic in the U.S.⁹ as well as in many other countries,¹⁰⁻¹³ routine dental treatment, particularly aerosol-generating procedures, were deferred to reduce the risk of COVID-19 transmission.^{14,15} As the pandemic continues, it is expected that the economic effects arising from resignations, layoffs and/or pay cuts will exacerbate the reduction in utilization of dental care, particularly for higher cost procedures and treatment not covered by insurance plans.¹⁶ Due to the progressive nature of developing dental caries,¹⁷ it can be hypothesized that more expensive dental services will be needed if preventive dental care was deferred during the pandemic.

The pandemic has exposed and worsened existing healthcare and other structural inequalities.^{6,18-20} For example, an Australian study showed the impact of COVID-19 on reducing the provision of dental services to children from lower socioeconomic backgrounds who already experienced higher levels of dental disease and disadvantage in accessing dental care prior to the pandemic.⁶ Given that U.S. school-based dental screening programmes and preventive programmes (such as sealant and fluoride varnish programmes) were significantly impacted negatively during the 2020–2021 school year,^{21,22} reductions in paediatric dental care utilization would also be expected in the U.S. As society gradually reopens and these school-based preventive dental programs resume, policy makers and school administrators will need data on which subgroups experienced the largest unmet dental need during the pandemic in order to plan and deliver targeted interventions. Furthermore, understanding how the utilization of dental versus medical services changed during the pandemic as well as the associated disparities and broader impacts, can help prioritize planning and funding for dental programmes that are more resilient and better prepared to handle future pandemics or public health emergencies, without an attendant reduction in the provision of essential dental services.

To date, no representative study has examined how the utilization of medical and dental services among U.S. children changed

during the pandemic, compared to before the pandemic, at both national and state levels. To fill these gaps in knowledge, this study examined: (1) What percentage of U.S. children reported utilizing dental versus medical services, respectively, before (2019) and during the COVID-19 pandemic (2020)? (2) Did the determinants of unmet dental needs change before versus during the COVID-19 pandemic? (3) What were the associations between having unmet dental needs during the pandemic and outcomes such as emergency room visits, missed days of work for parents and missed days of school attendance for the child because of the child's illness?

2 | MATERIALS AND METHODS

2.1 | Study population

A secondary analysis of existing data from the National Survey of Children's Health (NSCH),²³ a household cross-sectional survey conducted by the U.S. Census Bureau,²⁴ was conducted. The 2019 cycle of the survey was fielded between June 2019 and January 2020²⁵; fielding of the 2020 cycle started about 6 months into the COVID-19 pandemic, and questionnaires were completed between July 2020 and January 2021.²⁶ In both cycles, participants were mailed an invitation to complete a household screener and then a child-level questionnaire online using a secure, confidential website. Additionally, participants were provided the opportunity to complete a mailed, paper version instead of the web-based materials. The average overall response rate was 42.4% within both cycles.^{25,26} The 2019 NSCH surveyed $n = 29\,433$ children aged 0–17 years old,²⁵ while the 2020 survey had 42 777 completed surveys.²⁶ This analysis, however, was restricted to children aged 1–17 years old ($n = 28\,500$ in 2019 and $n = 41\,380$ in 2020). For the two years combined, the indicated study population therefore comprised 69 880 U.S. children aged 1–17 years who were surveyed in 2019 and 2020 from all 50 U.S. states and D.C. Newborns and infants aged <1 year old were excluded from the analyses because dental access was assessed for the 12 months prior to the survey—a period which in its entirety may have preceded the birth of some infants. Furthermore, restricting the study population to 1–17-year-olds ensured that all children assessed had some primary or permanent teeth present.

2.2 | Measures

2.2.1 | General and oral health status

Parent or caregiver-rated general and oral health status of the child was assessed subjectively with the questions 'In general, how would you describe [CHILD]'s health?'²⁷ and 'How would you describe the condition of [CHILD]'s teeth?'²⁷ Categorical response options for both questions were 'Excellent'; 'Very Good'; 'Good'; 'Fair' or 'Poor'. The latter two responses were classified as suboptimal status; the remainder were classified as optimal.

2.2.2 | Past-year dental visit and unmet dental needs

Any dental visit was defined as an affirmative response to the question 'During the past 12 months, did [CHILD] see a dentist or other oral health care provider for any kind of dental or oral health care?'²⁷

A preventive dental visit was assessed among those with a past-year dental visit and was defined as an affirmative answer to the question 'During the past 12 months, did this child see a dentist or other oral health care provider for preventive dental care, such as check-ups, dental cleanings, dental sealants, or fluoride treatments?'²⁷

Children were classified as having an unmet dental need if their parents reported lack of access to appropriate and/or timely treatment in the presence of a dental condition, as evidenced by either of the following indications: (1) the sampled child had 'a toothache, decayed teeth, or unfilled cavities' during the past 12 months, and yet the child did not see a dentist for any kind of dental care during the past 12 months²⁷; and (2) During the past 12 months, there was a time when the child needed dental healthcare, 'but it was delayed or not received'.²⁷

2.2.3 | Past-year medical visit and unmet medical needs

Any past-year medical visit was an affirmative answer to the question 'During the past 12 months, did this child see a doctor, nurse, or other health care professional for sick-child care, well-child check-ups, physical exams, hospitalizations or any kind of medical care?'²⁷

Among those reporting a past-year medical visit, access to preventive services was assessed as follows: 'During the past 12 months, how many times did this child visit a doctor, nurse, or other health care professional to receive a preventive check-up?'²⁷ Those answering 'one or more preventive visits' were classified as having preventive medical visits. Presence of a medical unmet need was defined as an affirmative answer to the question 'During the past 12 months, was there any time when this child needed health care but it was not received?'²⁷ To better characterize the type of unmet need, a new indicator with four categories were created: neither medical nor dental unmet needs; only medical unmet needs; only dental unmet needs; and both medical and dental unmet needs.

2.2.4 | Emergency room visits and direct/indirect costs of child healthcare

The authors' interest in exploring the relationship between unmet dental needs during COVID-19 with healthcare costs and emergency room (ER) visits was motivated by findings from a microsimulation study which predicted an increase in dental-related ER visits during the pandemic.²⁸ Within the context of this study, past-year visit to an ER was defined as a response of '1 time' or '2 or more times' to the question 'During the past 12 months, how many times

did this child visit a hospital emergency room?'²⁵ Cumulative out-of-pocket costs for any type of healthcare service was measured with the question 'How much money did you pay for this child's medical, health, dental, and vision care during the past 12 months?'²⁷ The categorical response options were dichotomized as <USD\$500 versus ≥USD\$500.

Besides these direct costs, lost parental productivity and missed school days for the child on account of the child's illness were studied, as well as how these negative outcomes were associated with unmet dental needs during the pandemic. Missed school days were assessed with the question 'During the past 12 months, about how many days did this child miss school because of illness or injury?'²⁷ This question was assessed only among school-enrolled children 6–17 years, and categorical response options among the indicated population were 'No missed school days', '1–3 days', '4–6 days', '7–10 days' and '11 or more days'. These categorical response options were dichotomized as <7 days versus ≥7 days (i.e. up to two academic weeks of absenteeism assuming a 5-day school week). A relatively high cut-off was used to discriminate between mild and serious conditions which would be expected to result in repeated or prolonged absenteeism from school. Lost parental productivity on account of the child was measured as a 'Yes' response to the question 'During the past 12 months, did you or anyone in the family have to quit a job, not take a job, or greatly change your job because of problems with childcare for this child?'²⁷

2.2.5 | Sociodemographic and other characteristics

Selection of covariates was undergirded by the socio-ecological model²⁹ and various child-level, parent/household-level and neighbourhood-level characteristics were assessed. Child-level characteristics included age (1–5; 6–11; or 12–17 years), gender (male or female), race/ethnicity (Hispanics; or non-Hispanic: Whites, Blacks or other race), U.S. Census region (Northeast, South, West and Midwest) and nativity status of the child (native or foreign-born). Parent or household-level characteristics included poverty index ratio measured relative to the Federal Poverty Level (FPL) (0%–99%, 100%–199%; 200%–399% or ≥400% of FPL); type of healthcare coverage (private only, public only, private and public, other or uninsured); highest educational level of either parent (less than high school, high school, some college, college); household structure defined on the basis of who the child lives with (one parent, two parents who are unmarried, two parents who are married, grandparents, and other unspecified individual); presence of smoker in household (yes or no); and nativity status of the parent (native or foreign-born). As a neighbourhood-level characteristic, neighbourhood safety was measured by whether the parent answered 'definitely agree' (vs. 'somewhat agree', 'somewhat disagree' or 'definitely disagree') to the statement 'This child is safe in our neighborhood'.²⁷ From the context of the broader policy environment, an assessment was made as to whether the child lived in a Medicaid hold-out state (Alabama, Florida, Georgia, Kansas, Mississippi, North Carolina, South Carolina,

South Dakota, Tennessee, Texas, Wisconsin, Wyoming) versus a Medicaid expanded state (all others).

2.3 | Data analyses

Data were weighted to adjust for non-response and to yield representative estimates at the national and state levels. Percentages with 95% confidence intervals were calculated nationally, and further stratified by state and other demographic characteristics. Any past-year dental or medical visit was assessed among all children aged 1–17 years; past-year preventive dental or medical visit was assessed among those children who had any past-year visit. Within-group differences were assessed with the Chi-squared test at $p < .05$. The key influencing factors of healthcare utilization and unmet medical and dental needs were analysed based on the Andersen healthcare utilization model³⁰: predisposing factors (sex, age, race, nativity status, household structure, region), need factors (health status) and enabling factors (insurance, poverty level, Medicaid expansion status). Adjusted prevalence ratios were calculated in multivariable Poisson regression models to explore correlates of reporting unmet medical and dental need before and during the COVID-19 pandemic, as a function of key explanatory variables. The relationship between having dental and/or medical unmet needs and various outcomes (such as suboptimal oral health, ER visits and direct and indirect costs of healthcare) were also measured. Analyses adjusted for the following confounders: having a smoker in the household; perceived neighbourhood safety; age; gender and race of child; nativity status; household structure; poverty level; U.S. census region; health insurance coverage and whether the child was in a Medicaid expansion state. All statistical analyses were performed in Stata Version 14 and R Version 3.6.3.

3 | RESULTS

3.1 | Characteristics of study population

Of the indicated study population aged 1–17 years in 2020, most were male (51.1%), non-Hispanic whites (48.9%) (Table 1). With respect to the type of health insurance, 58.2% of the study population were covered by private insurance only, 29.6% were covered by public health insurance only, 5% were covered by both private and public health insurance and 7.2% were uninsured. Overall, 98.9% of children in 2020 had their overall health rated by their parents as optimal, while 93.9% had their oral health rated by their parents as being in optimal condition. Parent-reported prevalence of dental decay among children aged 1–17 years old was 12.1% nationally, ranging from 6.8% in Nebraska to 16.1% in Louisiana (Figure S1). Subgroups with the highest prevalence of parent-reported dental decay in 2020 included children in families who lived below the federal poverty level (17.5%), reported food insufficiency (18.9%), received public assistance (17.4%), spoke English as a second language (18.3%), lived

TABLE 1 Characteristics of the study population among U.S. children aged 1–17 years, National Survey of Children's Health 2019–2020.

Characteristics	2019		2020	
	No.	%	No.	%
Age				
1–5 years old	7241	28.6	10 744	28.5
6–11 years old	9029	35.3	13 097	35.1
12–17 years old	12 230	36.1	17 539	36.4
Gender				
Male	14 838	51.1	21 381	51.1
Female	13 662	48.9	19 999	48.9
Race/Ethnicity				
Hispanic	3389	25.8	5579	25.8
White, non-Hispanic	19 784	50.1	27 364	49.9
Black, non-Hispanic	1835	13.3	2833	13.3
Other, non-Hispanic	3492	10.8	2276	11
Primary language spoken at home				
English	26 579	86.1	38 222	85
Other language	1783	13.9	3011	15
Nativity status of the parents				
US-born	21 961	66.9	31 272	67.4
Foreign-born	4630	25.3	7248	25.7
Other	1577	7.8	2150	6.9
Nativity status of the child				
US-born	27 409	95.9	39 562	95.4
Foreign-born	905	4.1	1410	4.6
Family structure of child's household				
Two married parents	19 758	65.3	27 691	63.5
Two unmarried parents	1868	8.5	2295	7.7
Single parent	5100	20.6	8523	23.8
Grandparent(s)	912	3.8	1152	3.6
Other	273	1.8	376	1.4
Head of household education level				
Less than high school	677	9.4	1113	9.7
High school degree or General Educational Development (GED)	3625	18.8	5539	19.5
Some college or technical school	6647	21.7	9381	20.6
College degree or higher	17 551	50.1	25 347	50.2
Number of family members in the child's household				
≤2	1761	5	2972	5.8
3	8526	21.1	12 132	20.3
4	10 656	32.1	15 229	31.8
5	4740	24.5	6761	24.2

TABLE 1 (Continued)

Characteristics	2019		2020	
	No.	%	No.	%
6	2009	12.8	3004	13.8
NA	808	4.5	1282	4.1
Living in Medicaid expansion state				
No	6751	31.4	9697	31.8
Yes	21 749	68.6	31 683	68.2
U.S. census region				
Northeast	5034	15.7	6609	15.7
Midwest	6448	20.9	9738	21
West	7293	24.7	12 601	24.3
South	9725	38.7	12 432	39
Poverty level				
0%–99% FPL	3133	18.7	5180	17.9
100%–199% FPL	4693	21.4	7009	21.8
200%–399% FPL	9029	28.9	12 571	29.4
400% FPL or greater	11 645	31	16 620	30.9
Health insurance type				
Public only	5637	29.2	8622	29.6
Private only	20 043	59.3	28 440	58.2
Private and public	1035	4.8	1681	5
Not insured	1331	6.7	2026	7.2

Abbreviation: FPL, federal poverty level.

with a smoker in the household (17.9%) and were Hispanic (15.8%) (Figure S2).

3.2 | Prevalence of past-year medical and dental visits

Between 2019 and 2020, significant decreases occurred for any past-year dental visit (82.6%–78.2%), preventive dental visit (80.1%–74.9%), any past-year medical visit (87.2%–81.3%) and preventive medical visit (83.1%–77.7%) (all $p < .01$). Conversely, significant increases were seen in the prevalence of unmet medical needs (3.2%–4.2%, $p = .0049$) and unmet dental needs (2.9%–4.4%, $p = .0002$). No significant difference, however, was seen in reported costs between the 2 years.

Among population subgroups in 2020, any past-year dental visit was lowest among children aged 1–5 years (56.7%), those with the highest parental educational level below high school (69.5%) and Florida residents (72.6%) (Table 2). Comparison of preventive visits between 2019 and 2020 revealed that the following groups had the largest decrease in utilization of preventive dental services: ages 1–5 years (61.8%–53.9%), Blacks (78.0%–69.4%), children with unmarried parents (79.6%–67.3%), children living with a grandparent (76.3%–68.3%), children who were foreign born (74.8%–67.2%), and those who were living in households at 0%–99% of the FPL

(73.7%–64.3%). States with the largest decreases were California (83.6%–71.2%), Iowa (86.6%–77.5%) and Minnesota (79.4%–71.4%).

Subgroups reporting the lowest prevalence for any past-year medical visits in 2020 included groups who used food stamps, had food insufficiency, lived with a smoker in their household, had foreign-born parents, were aged 12–17 years, belonged to racial minority groups, had highest parental educational level as high school and lower. Most of these subgroups also experienced the largest decrease in utilization of preventive medical services between 2019 and 2020. Also see Table S1 for the prevalence of past-year any medical and dental visits categorized by states, and Table S2 for the prevalence of past-year preventive medical and medical visits categorized by states.

3.3 | Shifts in correlates of unmet medical and dental needs

While certain correlates of unmet dental needs remained consistent for both the pre- versus intra-pandemic periods, shifts were seen in other determinants (Table 3). For example, the adult with whom the child lived was not significantly associated with unmet dental needs before the pandemic but was significant during the pandemic. The likelihood of unmet dental needs during the pandemic was four-fold higher among children living with their grandparents (Adjusted Prevalence Ratio, APR = 4.26, 95% CI = 1.05–17.28) as well as those living with other unspecified adults who were not their parents (APR = 4.48, 95% CI = 1.54–13.01) than those living with both married parents. Pre-pandemic, only children without insurance had significantly higher likelihood of having unmet needs than those with private insurance. During the pandemic, however, the likelihood of unmet dental needs remained high among the uninsured (APR = 4.76, 95% CI = 3.38–6.69) but was also significantly higher even among those with public-only insurance (APR = 2.24, 95% CI = 1.57–3.19), public and private insurance (1.92, 95% CI = 1.19–3.11) than those with private insurance. Both before and during the pandemic, children living in unsafe neighbourhoods and those living with a smoker in the household reported higher likelihood of having unmet dental needs than those not reporting such living conditions.

Whereas Medicaid expansion status was protective of unmet medical needs during the pandemic (APR = 0.69, 95% CI = 0.54–0.89), it was not significantly associated with unmet dental needs, before (APR = 0.84, 95% CI = 0.57–1.24) or during the pandemic (APR = 0.96, 95% CI = 0.75–1.22). Many of the individual and neighbourhood-level factors that were associated with unmet dental needs were also associated with unmet medical needs as shown in Table 3. Also see Table S3 for data categorized by states.

3.4 | Associations between unmet medical/dental needs and various health-related outcomes

After adjusting for several confounding influences, significant associations were seen between unmet health needs and several

TABLE 2 Percentage of U.S. children aged 1–17 years old with any past-year dental and medical visits in 2019 and 2020 based on parent-reported information, National Survey of Children's Health 2019–2020.

Characteristics	Categories	Past dental visits		Past medical visits	
		Any dental visit, 2019 (95% CI)	Any dental visit, 2020 (95% CI)	Any medical visit, 2019 (95% CI)	Any medical visit, 2020 (95% CI)
Total	Overall	82.6 (81.6–83.7)	78.2 (77.0–79.2)	87.2 (86.0–88.1)	81.3 (80.3–82.2)
Food insufficiency	Sufficient food	84.3 (83.1–85.5)	80.7 (79.6–81.8)	87.7 (86.6–88.7)	82.8 (81.8–83.9)
	Insufficient food	79.0 (77.0–81.1)	73.2 (71.2–75.2)	86.7 (85.1–88.4)	78.4 (76.6–80.3)
Food stamp	Did not receive food or cash assistance	84.1 (82.9–85.3)	80.7 (79.7–81.8)	88.6 (87.6–89.6)	83.9 (82.8–84.9)
	Received food or cash assistance	80.3 (78.4–82.3)	75.4 (73.6–77.1)	85.3 (83.7–87.0)	78.3 (76.6–80.0)
Smoker in household	No one in household uses tobacco	83.4 (82.3–84.5)	79.1 (78.1–80.1)	87.5 (86.6–88.5)	81.8 (80.8–82.9)
	Someone in household uses tobacco	77.9 (75.0–80.7)	74.0 (71.3–76.6)	85.8 (83.7–87.9)	79.4 (76.8–82.0)
Living in supportive neighbourhood	Not supportive neighbourhood	80.9 (79.2–82.5)	75.4 (73.8–77.1)	87.8 (86.6–89.1)	80.8 (79.2–82.3)
	Supportive neighbourhood	84.4 (83.0–85.7)	80.9 (79.8–82.0)	87.1 (85.8–88.4)	82.4 (81.3–83.6)
Living in safe neighbourhood	Unsafe neighbourhood	81.0 (79.2–82.9)	75.8 (73.9–77.7)	88.0 (86.6–89.4)	81.2 (79.5–82.9)
	Safe neighbourhood	83.7 (82.4–85.0)	80.0 (78.9–81.0)	86.9 (85.8–88.1)	81.8 (80.7–83.0)
Age of child	1–5 years old	64.0 (61.7–66.3)	56.7 (54.7–58.8)	91.2 (89.8–92.7)	89.1 (87.7–90.6)
	6–11 years old	90.4 (88.8–92.1)	88.0 (86.6–89.4)	86.3 (84.7–87.9)	80.0 (78.4–81.7)
	12–17 years old	89.7 (88.3–91.1)	85.6 (84.2–87.0)	84.9 (83.3–86.4)	76.2 (74.6–77.8)
Gender of child	Male	82.4 (81.0–83.8)	77.6 (76.3–78.9)	87.3 (86.1–88.5)	81.5 (80.3–82.7)
	Female	82.8 (81.4–84.3)	78.9 (77.5–80.3)	87.1 (85.8–88.4)	81.0 (79.6–82.4)
Race/Ethnicity of child	Hispanic	81.5 (78.6–84.4)	76.7 (74.0–79.3)	84.5 (82.0–87.0)	75.3 (72.6–78.0)
	White, non-Hispanic	83.4 (82.3–84.4)	81.0 (80.1–82.0)	88.9 (88.1–89.8)	85.9 (85.0–86.7)
	Black	81.8 (78.8–84.8)	74.4 (71.7–77.2)	86.9 (84.4–89.3)	78.1 (75.5–80.7)
	Other, non-Hispanic	82.9 (80.4–85.3)	73.8 (71.1–76.5)	85.9 (83.4–88.3)	78.1 (75.5–80.7)
Nativity status of parent(s)	US-born	83.5 (82.3–84.6)	79.7 (78.7–80.7)	89.1 (88.2–90.0)	84.5 (83.6–85.4)
	Foreign-born	82.2 (79.8–84.6)	77.0 (74.7–79.4)	84.9 (82.8–87.0)	75.1 (72.6–77.6)
	Other	76.6 (72.0–81.3)	70.3 (66.0–74.6)	81.1 (76.8–85.5)	76.3 (72.3–80.3)
Primary language spoken at home	English	83.3 (82.3–84.4)	79.6 (78.7–80.5)	88.4 (87.6–89.3)	83.9 (83.0–84.7)
	Other	78.2 (74.3–82.1)	70.7 (67.0–74.4)	80.1 (76.6–83.6)	66.9 (63.1–70.8)
Family structure of child's household	Two married people	83.4 (82.1–84.7)	80.8 (79.7–81.8)	89.1 (88.1–90.1)	83.9 (82.7–85.0)
	Two unmarried people	82.7 (79.1–86.3)	70.0 (65.4–74.6)	86.0 (82.7–89.2)	81.2 (77.6–84.8)
	Single parent	82.7 (80.6–84.7)	77.0 (74.9–79.0)	84.5 (82.5–86.6)	76.4 (74.4–78.5)
	Grandparent(s)	78.2 (73.1–83.3)	72.3 (67.2–77.5)	81.4 (76.0–86.7)	80.3 (75.9–84.8)
	Other	68.8 (55.7–81.9)	64.2 (53.9–74.5)	75.6 (63.6–87.7)	67.8 (57.8–77.8)
% of Federal poverty level	0%–99%	77.7 (74.7–80.7)	70.4 (67.6–73.2)	81.7 (79.1–84.4)	72.0 (69.3–74.7)
	100%–199%	78.4 (75.6–81.1)	75.2 (73.0–77.4)	86.0 (84.0–88.0)	77.9 (75.4–80.3)
	200%–399%	84.0 (82.4–85.7)	78.5 (76.8–80.3)	87.1 (85.4–88.7)	80.7 (79.0–82.4)
	≥400%	87.2 (85.8–88.6)	84.6 (83.4–85.8)	91.4 (90.3–92.6)	89.5 (88.6–90.4)
Head of household education level	Less than High school	74.3 (68.6–80.0)	69.5 (64.5–74.6)	74.1 (68.7–79.6)	64.0 (58.7–69.3)
	High school	79.4 (76.7–82.1)	72.5 (70.0–75.1)	81.7 (79.3–84.1)	72.1 (69.5–74.6)
	Some college	81.9 (80.1–83.8)	77.1 (75.2–79.0)	86.2 (84.5–87.9)	80.4 (78.7–82.2)
	College	85.7 (84.5–86.9)	82.6 (81.6–83.6)	92.1 (91.3–93.0)	88.5 (87.7–89.3)
Nativity status of child	US-born	82.8 (81.8–83.9)	78.6 (77.6–79.5)	87.9 (87.0–88.7)	81.9 (81.0–82.9)
	Foreign-born	77.6 (70.7–84.5)	71.1 (65.5–76.7)	75.1 (68.3–81.9)	68.7 (62.9–74.5)

TABLE 2 (Continued)

Characteristics	Categories	Past dental visits		Past medical visits	
		Any dental visit, 2019 (95% CI)	Any dental visit, 2020 (95% CI)	Any medical visit, 2019 (95% CI)	Any medical visit, 2020 (95% CI)
Household size (number of people)	≤2 people	84.5 (81.1–87.9)	79.1 (75.9–82.4)	82.5 (77.8–87.2)	79.5 (76.2–82.8)
	3 people	78.9 (76.7–81.0)	74.9 (73.0–76.8)	87.3 (85.5–89.1)	81.5 (79.6–83.4)
	4 people	84.5 (83.0–86.0)	80.9 (79.5–82.3)	88.8 (87.5–90.2)	83.3 (81.8–84.9)
	5 people	84.3 (81.9–86.6)	80.3 (78.3–82.2)	88.5 (86.7–90.3)	82.9 (81.0–84.7)
	≥6 people	80.9 (77.3–84.6)	76.0 (72.7–79.3)	83.6 (80.6–86.7)	76.8 (73.7–79.9)
	Unknown	80.4 (75.1–85.8)	68.2 (61.6–74.7)	83.3 (78.4–88.1)	71.7 (65.5–77.8)
Living in Medicaid expansion state	Medicaid-holdout state	79.6 (77.4–81.8)	77.9 (76.1–79.7)	85.9 (84.0–87.8)	80.6 (78.8–82.4)
	Medicaid-expanded state	84.0 (82.9–85.1)	78.4 (77.3–79.5)	87.8 (86.8–88.8)	81.6 (80.5–82.6)

health-related outcomes. Compared with children whose medical and dental needs were both met, children with unmet dental needs only, reported higher likelihood of poor teeth (APR = 4.70, 95% CI = 3.39–6.52), ER visits (APR = 1.43, 95% CI = 1.02–2.00), missing school for up to two academic weeks on account of illness (APR = 1.98, 95% CI: 1.21–3.24), and missing work by their parents because of the child's illness (APR = 2.08, 95% CI = 1.19–3.65) (Table 4). Those reporting having both medical and dental unmet needs were also more likely than those with none, to report having poor teeth (APR = 4.20, 95% CI = 3.05–5.78), missed days of school (APR = 1.61, 95% CI = 1.13–2.28) and missed days of work by parents due to the child (APR = 2.48, 95% CI = 1.71–3.61). There was no significant association between having unmet dental needs alone or with unmet medical needs, and reporting child healthcare spending amounting to USD\$500 and more. Unmet medical needs alone were, however, associated with higher out-of-pocket costs for healthcare compared with those with no medical or dental unmet needs (1.82, 95% CI: 1.46–2.27). Unmet medical needs were also associated with increased ER visits, missed days of work and school, but were not significantly associated with poor teeth.

4 | DISCUSSION

The findings from this study show a reduced utilization of both medical (87.2%–81.3%) and dental services (82.6%–78.2%) between 2019 (i.e. before the COVID-19 pandemic) and 2020 (i.e. during the pandemic). During this time, unmet health needs increased for both medical and dental services—but more for unmet dental needs (51.7% increase, from 2.9% to 4.4%) versus unmet medical needs in general (31.3% increase, from 3.2% to 4.2%). Disparities in dental access during the pandemic were amplified along the lines of geographic location and socio-economic status with past-year dental utilization being lowest among children from certain racial/ethnic minorities and low socio-economic backgrounds. As such, future research and policy interventions should focus on building resilience in children from underserved groups by improving their baseline level of oral health and access to

preventive and corrective dental care (during 'normal times'); so that in times of future pandemics or public health emergencies where access to dental care is restricted, they can better weather any deterioration in oral health until such time that access is restored.

This study showed that Medicaid expansion was a protective factor for medical unmet needs but not for dental unmet needs. For instance, during the pandemic the percentage of children aged 1–17 with dental unmet needs were 4.2% (95% CI = 3.5–4.8) in Medicaid-expanded states compared with 5.0% (95% CI = 3.9–6.1) in Medicaid-holdout states (i.e. a difference of 0.8%, 95% CI = 0.4–1.3). On the contrary, the percentage of children aged 1–17 with medical unmet needs during the pandemic were 3.8% (95% CI = 3.2–4.3) in Medicaid-expanded states compared to 5.2% (95% CI = 4.0–6.4) in Medicaid-holdout states (i.e. a difference of 1.4%, 95% CI = 0.8–2.0). This may be attributed to more medical care providers than dental care providers accepting patients with Medicaid,³¹ which partly explains why disadvantaged children often face difficulties accessing dental care even though Medicaid covers preventive and comprehensive dental benefits.³² The disruption caused by COVID-19 to in-person access to care necessitates bringing dental care into the community by 'expanding community-clinical linkage programs',³³ such as school-based dental programs and teledentistry. For example, policy makers can target schools that have a high percentage of children using the Free and Reduced-Price Lunch Program (FRLP), which is a proxy measure for students from low-income families,³⁴ to narrow inequalities in accessing dental care.

In this study, significant associations were found during the pandemic between children living with their grandparents or with unmarried parents and reduced access to dental care (whereas no such associations were seen pre-pandemic). This may be partially attributed to elderly adults being among the high-risk group during the COVID-19 pandemic and their need to take necessary precautions to avoid and/or reduce exposure. These findings are also consistent with earlier findings from the National Health Interview Survey that showed that children living with non-nuclear families (defined as single-parent families, unmarried or cohabiting biological or adoptive families, and extended families), tended to have greater unmet

TABLE 3 Percentage of U.S. children aged 1–17 years old with unmet dental needs and health care cost in 2019 and 2020 based on parent-reported information, National Survey of Children's Health 2019–2020.

Characteristics	Categories	Dental unmet needs		Health care cost	
		Dental unmet needs, 2019 (95% CI)	Dental unmet needs, 2020 (95% CI)	Health care cost ≥\$500, 2019 (95% CI)	Health care cost ≥\$500, 2020 (95% CI)
Total		2.9 (2.4–3.4)	4.4 (3.8–5.0)	24.6 (23.6–25.6)	23.9 (23.1–24.7)
Food insufficiency	Sufficient food	1.4 (1.1–1.8)	2.5 (2.0–3.0)	26.9 (25.7–28.2)	26.0 (25.0–26.9)
	Insufficient food	6.2 (4.7–7.6)	9.0 (7.4–10.5)	19.9 (18.1–21.7)	18.8 (17.3–20.3)
Food stamp	Did not receive food or cash assistance	1.5 (1.1–1.9)	2.5 (2.1–3.0)	33.1 (31.8–34.4)	32.7 (31.6–33.8)
	Received food or cash assistance	5.3 (4.1–6.5)	7.1 (5.8–8.3)	11.0 (9.5–12.5)	11.9 (10.7–13.0)
Smoker in household	No one in household uses tobacco	2.5 (2.0–3.0)	3.9 (3.3–4.5)	25.6 (24.5–26.7)	24.9 (24.0–25.8)
	Someone in household uses tobacco	5.6 (3.5–7.7)	7.5 (5.4–9.5)	19.3 (17.0–21.6)	17.4 (15.5–19.4)
Living in supportive neighbourhood	Not supportive neighbourhood	4.0 (3.0–4.9)	6.5 (5.4–7.6)	23.8 (22.2–25.4)	22.7 (21.3–24.0)
	Supportive neighbourhood	2.0 (1.4–2.6)	2.7 (2.1–3.3)	25.6 (24.2–27.0)	25.0 (24.0–26.0)
Living in safe neighbourhood	Unsafe neighbourhood	4.0 (2.9–5.0)	7.2 (5.8–8.6)	22.5 (20.8–24.2)	21.6 (20.1–23.1)
	Safe neighbourhood	2.3 (1.7–2.9)	3.0 (2.5–3.5)	26.0 (24.7–27.3)	25.1 (24.2–26.1)
Age of child	1–5 years old	2.1 (1.5–2.6)	3.7 (2.6–4.7)	20.0 (18.3–21.8)	19.3 (17.9–20.8)
	6–11 years old	3.1 (2.0–4.2)	4.4 (3.5–5.2)	21.7 (20.0–23.5)	21.9 (20.5–23.2)
	12–17 years old	3.4 (2.6–4.3)	5.0 (3.9–6.1)	31.1 (29.3–32.8)	29.3 (27.9–30.7)
Gender of child	Male	2.8 (2.1–3.5)	3.9 (3.3–4.5)	25.4 (23.9–26.9)	24.3 (23.2–25.4)
	Female	3.1 (2.3–3.9)	4.9 (3.9–5.9)	23.8 (22.4–25.2)	23.4 (22.3–24.6)
Race/ethnicity of child	Hispanic	4.6 (3.0–6.3)	6.9 (5.1–8.7)	18.8 (16.0–21.7)	16.5 (14.7–18.3)
	White, non-Hispanic	2.1 (1.7–2.5)	3.0 (2.5–3.5)	30.1 (29.0–31.2)	30.1 (29.2–31.1)
	Black, non-Hispanic	3.7 (2.3–5.1)	4.9 (3.6–6.3)	13.7 (11.5–16.0)	13.5 (11.4–15.6)
	Other, non-Hispanic	1.7 (1.0–2.3)	4.3 (2.8–5.8)	26.1 (23.2–29.1)	24.8 (22.4–27.2)
Nativity status of parent(s)	US-born	2.4 (1.9–2.9)	4.1 (3.5–4.8)	27.3 (26.2–28.5)	26.5 (25.6–27.5)
	Foreign-born	4.0 (2.5–5.5)	5.0 (3.7–6.4)	21.6 (19.0–24.1)	20.2 (18.4–22.0)
	Other	4.3 (2.5–6.2)	4.7 (3.0–6.5)	12.0 (8.4–15.6)	12.1 (9.5–14.7)
Primary language spoken at home	English	2.5 (2.1–3.0)	3.8 (3.3–4.3)	26.3 (25.3–27.4)	25.7 (24.8–26.5)
	Other	5.3 (2.9–7.8)	7.8 (5.3–10.3)	14.4 (11.0–17.7)	13.6 (11.3–15.9)
Family structure of child's household	Two married people	2.5 (1.8–3.2)	3.2 (2.6–3.7)	29.1 (27.7–30.4)	29.0 (27.9–30.0)
	Two unmarried people	3.8 (1.9–5.6)	9.3 (5.7–12.9)	18.1 (14.5–21.7)	16.2 (13.1–19.3)
	Single parent	3.2 (2.4–4.1)	5.9 (4.4–7.4)	18.4 (16.2–20.6)	16.4 (14.9–17.8)
	Grandparent(s)	5.2 (2.1–8.3)	5.4 (2.5–8.3)	8.2 (5.5–10.9)	9.2 (5.9–12.5)
	Other	3.0 (0.6–5.4)	9.2 (3.7–14.7)	6.9 (2.8–11.1)	4.4 (1.9–7.0)
% of Federal poverty level	0%–99%	5.8 (3.9–7.6)	6.9 (5.4–8.4)	8.6 (6.3–11.0)	7.9 (6.5–9.3)
	100%–199%	4.6 (3.1–6.0)	5.3 (4.0–6.6)	13.0 (11.2–14.8)	15.0 (13.3–16.7)
	200%–399%	2.3 (1.6–2.9)	5.2 (3.9–6.6)	29.5 (27.5–31.4)	25.9 (24.4–27.4)
	≥400%	0.7 (0.3–1.0)	1.6 (1.2–1.9)	37.5 (35.7–39.4)	37.1 (35.7–38.6)
Head of household education level	Less than High school	7.0 (3.5–10.4)	8.0 (4.9–11.1)	10.9 (6.1–15.7)	8.6 (5.6–11.6)
	High school	4.4 (2.9–5.9)	6.2 (4.5–7.8)	12.0 (10.0–14.1)	12.8 (11.2–14.5)
	Some college	3.9 (2.8–4.9)	6.0 (4.6–7.4)	19.3 (17.4–21.1)	19.5 (18.0–21.0)
	College	1.2 (0.9–1.5)	2.4 (2.0–2.9)	34.1 (32.7–35.5)	32.7 (31.6–33.9)

TABLE 3 (Continued)

Characteristics	Categories	Dental unmet needs		Health care cost	
		Dental unmet needs, 2019 (95% CI)	Dental unmet needs, 2020 (95% CI)	Health care cost ≥\$500, 2019 (95% CI)	Health care cost ≥\$500, 2020 (95% CI)
Nativity status of child	U.S. born	2.7 (2.2–3.2)	4.2 (3.7–4.8)	24.6 (23.6–25.6)	24.1 (23.2–24.9)
	Foreign born	8.0 (1.5–14.4)	8.4 (4.3–12.4)	24.2 (17.7–30.6)	19.9 (16.0–23.8)
Household size (number of people)	≤2 people	3.3 (1.9–4.7)	4.6 (3.2–6.1)	22.4 (17.8–27.)	17.3 (14.9–19.7)
	3 people	3.6 (2.5–4.8)	4.6 (3.4–5.9)	26.0 (24.1–28.0)	25.1 (23.6–26.6)
	4 people	2.3 (1.5–3.0)	3.7 (2.8–4.5)	27.5 (25.9–29.1)	26.5 (25.2–27.8)
	5 people	2.9 (1.6–4.3)	4.4 (3.1–5.7)	25.0 (22.4–27.5)	23.6 (21.8–25.5)
	≥6 people	3.1 (1.9–4.3)	5.7 (3.7–7.7)	17.9 (15.2–20.7)	20.1 (17.6–22.7)
	Unknown	3.0 (1.1–4.9)	4.7 (1.9–7.4)	16.1 (10.0–22.1)	20.1 (15.5–24.8)
Living in Medicaid expansion state	Medicaid-holdout state	4.0 (2.6–5.3)	5.0 (3.9–6.1)	24.8 (22.9–26.8)	23.8 (22.2–25.5)
	Medicaid-expanded state	2.4 (2.0–2.9)	4.2 (3.5–4.8)	24.5 (23.3–25.7)	23.9 (23.0–24.8)

TABLE 4 Poisson regression analysis of the associations between having dental and/or medical unmet needs during the COVID-19 pandemic and various health outcomes, National Survey of Children's Health 2020.

	Poor teeth ^a APR (95% CI)	ER visit APR (95% CI)	Costs of healthcare ≥\$500 APR (95% CI)	Parent missed work APR (95% CI)	Child missed class up to two academic weeks APR (95% CI)
Unmet medical needs	1.24 (0.64–2.40)	2.02 (1.52–2.69)	1.82 (1.46–2.27)	3.40 (2.54–4.56)	3.43 (2.59–4.53)
Unmet dental needs	4.70 (3.39–6.52)	1.43 (1.02–2.00)	0.84 (0.61–1.18)	2.08 (1.19–3.65)	1.98 (1.21–3.24)
Both unmet medical and dental needs	4.20 (3.05–5.78)	1.11 (0.79–1.54)	1.11 (0.75–1.66)	2.48 (1.71–3.61)	1.61 (1.13–2.28)

Note: Adjusted for having a smoker in the household; perceived neighbourhood safety; age; gender and race of child; nativity status; household structure; poverty level; U.S. census region; health insurance coverage; and whether the child was in a Medicaid expansion state.

Abbreviations: APR, adjusted prevalence ratio; ER, emergency room.

^aAssessed with the question 'How would you describe the condition of [CHILD]'s teeth?' Categorical response options were 'Excellent'; 'Very Good'; 'Good'; 'Fair' or 'Poor'. The latter two responses were classified as suboptimal status; the remainder were classified as optimal.

dental needs than those living with nuclear families.³⁵ Moreover, elderly Americans who are Medicare beneficiaries have been reported to have difficulties accessing healthcare, especially dental care, during the pandemic³⁶; this is important as elderly persons unable to access healthcare for themselves may be unable to do so likewise for their grandchildren as well because of their own health limitation. The observation that children living with a smoker in the household were more likely to have unmet dental needs is also consistent with earlier research showing higher utilization of emergency medical services and lower likelihood of having dental care visits among children living with a household member who smoked.³⁷

A novel contribution of this study is providing state-specific prevalence estimates of paediatric dental access during the pandemic using representative data at the state and national levels. A potential application of this study's findings is to identify 'target sub-populations' to prioritize during the planning and implementation of state dental public health programmes. The wide variability in past-year dental visits across states underscores the need for tailored interventions within different

communities that aim to improve baseline levels of oral health and dental access. Nonetheless, the findings in this study are subject to several limitations. First, the data were self-reported and cross-sectional; as such, only associations rather than causality can be inferred. Second, nuanced information did not exist on certain indicators, such as whether care was delivered in person or virtually, whether dental care was provided in non-dental settings (e.g. physician offices), whether out-of-pocket costs were delineated by medical or dental care, or consideration of the varying periods of lock-down across different U.S. states when use of elective dental procedures were reduced. Third, the sampling frame does not capture youth in boarding homes, college dormitories or institutionalized settings such as juvenile correction settings.

5 | CONCLUSION

The COVID-19 pandemic was associated with reduced utilization of both medical and dental services and a corresponding increase in

perceived unmet health needs, especially for dental care. The results suggest that unmet dental needs are profoundly consequential, impacting various indicators of health and wellbeing for the affected children and their families. Taken together, these findings underscore the need for deliberate interventions, that aim to narrow oral health disparities and facilitate access to care during 'normal times', targeting the most affected groups to build resilience in future pandemics and public health emergencies.

AUTHOR CONTRIBUTIONS

SK and ITA conceived the research question. All the authors jointly designed the study. SK, GTFC, HM, DP and ITA jointly performed the data analyses, interpreted the findings, and wrote the manuscript (led by ITA). GWT and EMO-U critically revised the manuscript. GTFC undertook the editorial and formatting work.

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CONFLICT OF INTEREST

The authors declare that no financial support was received for the conduct of this study and that there is no potential conflict of interest.

DATA AVAILABILITY STATEMENT

The primary datasets used in this study are publicly available, and additional findings can be found in the supplementary figures and tables.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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